Center for Independent Experts (CIE) Independent Peer Review Report of Methods Review of the Canadian Swept-Area Trawl Survey conducted along the West Coast of Vancouver Island for Inclusion into the Pacific Sardine Stock Assessment

NOAA / Southwest Fisheries Science Center

La Jolla, California

May 29-31, 2012

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1. Executive Summary

Initially there were identified six aspects which provided a focus for discussions during the review:

1. Design of the trawl sampling, representativeness of the data for the density of Pacific Sardine;
2. Spatial sampling and raising to area, evaluation of potential biases in sampling design and analysis;
3. Overall applicability of biomass estimates as an index or absolute abundance;
4. Methodology of estimates of size and age proportions;
5. Estimates of variance by year; and
6. Suitability of the West Coast of Vancouver Island (WVCI) trawl survey estimates for use in stock assessments and management advice for Pacific sardine.

Linda Flostrand and Jake Schweigert of the Department of Fisheries and Oceans (DFO) Canada provided presentations on the History of the WCVI Trawl Survey and WCVI Trawl Survey Methods and Results. Paul Crone, representing the National Marne Fisheries Service (NMFS), Southwest Fisheries Science Center (SWFSC), presented background for the Inclusion of the WCVI Trawl Survey in the U.S. Sardine Assessment. Based on the report and presentation a set of requests for additional work was put forward and later reported.

The WVCI Survey Report, the presentations during the meeting, and the additional work carried out during the review provide a good basis to evaluate the performance of the WVCI trawl survey. In summary, the available materials indicate that the survey is run so as to allow an evaluation of the variation in abundance of Pacific sardine in Canadian waters. The consistency of the time series was questioned due to the change of survey practice over the years. There is a need for standardization of equipment and procedures for future surveys to enhance consistency, and development of a detailed survey manual would be beneficial.

The WVCI trawl survey time series can be considered to give estimates of distribution of abundance of Pacific Sardine for the survey area. Minor reanalysis is required to update estimates of precision for some years. Some limited exploration is required to evaluate the sensitivity of the abundance estimates to tow length and time of day. Some model and index development is required primarily to determine the proportion of Pacific sardine in Canadian waters at the time of the survey, before the best use of the survey can be obtained within the assessment.

2. Background

The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. A Statement of Work (Annex 2) is established by the NMFS Project Contact and Contracting Officer's Technical Representative, and reviewed by the CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee. Further information on the CIE process can be obtained from www.ciereviews.org.

This independent reviewer was requested to participate in a panel-review to conduct independent peer review of methods used in the Canadian Swept-Area Trawl Survey conducted along the West Coast of Vancouver Island (WCVI) and advise on its inclusion into the Pacific sardine stock assessment. As the survey area off the west coast of the Vancouver Island only covers part of the "tail" of the northward migrating Pacific sardine and is incomplete for the east-west distribution, a careful study of how to handle this information quantitatively is needed. The latitudinal and offshore extents of the Pacific sardine are seasonal, extending further north in the summer and further offshore in the spring. Survey estimates are presented in terms of absolute biomasses but are also considered to be indices of biomass due to uncertainties in the conversion from catches to densities. The abundance/biomass and their total random sampling errors, age and length structure, and spatial distributions are estimated. The review concerns technical aspects of the survey and sampling design, method including the equipment, analysis, and results and how this might be used in an assessment of the whole Pacific sardine stock.

3. Reviewer's Role in the Review Activities

My expertise is mainly in fisheries research survey methodologies. I have long experience in running combined acoustic - trawl surveys for demersal and pelagic fish as well as development of survey methods and survey protocols for standard surveys. Further, interaction between survey gear/vessel and the targeted fish is of crucial importance for the survey results, and thus, natural fish behavior as well as gear/vessel affected behavior has been an integrated part of my survey methodology work. I have followed survey assessment through to the final analytical stock assessment in the International Council on the Exploration of the Sea (ICES) working groups. For about 20 years my main obligation at Institute of Marine Research (IMR) was survey stock assessment. Since about 2000, I have been in charge of IMR's work on observation and survey methodologies, and in most recently years I have chaired the developing the concept "Marine Ecosystem Acoustics" as an avenue for survey assessment of ecosystems.

I have served as member and chair in program committees at the Research Council of Norway with objectives to enhance observation and survey methodologies. I have also participated in a SCORE working group on similar subject. My experience within the field also includes serving on the scientific steering committee of Census of Marine Life.

I have published about 70 peer-reviewed papers and several book chapters largely within the area of survey methodology and fisheries biology with relevance to stock assessment.

My role in the present review include all aspects of the work but with a focus on the technicalities of the survey equipment and survey routines, calculation of density estimates and their variance and bias, and the use of the result in the final stock assessment of Pacific Sardine.

4. Summary of findings by Term of Reference

As specified in Terms of Reference for the Peer Review, this report is organized under sections in accordance to the ToR.

In addition to the details provided under this structure, the report contains overall conclusions (Section 5) and a summary of collected recommendations (Section 6).

4.1. Review of documents

ToR 1: Review documents pertinent to the topic under consideration

The review was based on one prime document: Canadian west coast of Vancouver Island summer sardine research trawl surveys, 1999-2011. The 16 papers listed in Appendix 1 were provided as background for the work. On the first morning Linda Flostrand and Jake Schweigert of the Department of Fisheries and Oceans (DFO) Canada provided presentations on the History of the WCVI Trawl Survey and WCVI Trawl Survey Methods and Results. Paul Crone, representing the National Marne Fisheries Service (NMFS), Southwest Fisheries Science Center (SWFSC), presented background for the Inclusion of the WCVI Trawl Survey in the U.S. Sardine Assessment. These presentations and associated discussion took the whole day. The discussions brought forward and identified additional specific issues for further analysis by the Canadian survey team. Responses to the 10 identified issues were presented and discussed during the next two days.

The meeting was well organized with all the documentation provided well in time prior to the meeting. The survey team concentrated its presentation on survey results but also described changes in geographic coverage and design of the survey over time. Less specific was the presentation on the technicalities of survey (survey gear, instrumentation and operation). Most of these issues were clarified during the discussions but this part of the survey methodology is at an early stage of development. The team was well prepared and provided a good overview and was cooperative, hard working and supportive towards the completion of the review.

4.2. Outcome of the evaluation

ToR 2: Evaluation of the technical merits and deficiencies of the proposed methods

This section details the review of survey methodology, including gear type, deployment, survey design and data analysis, The recommendations arising from this are given in the next section (4.3) under matching headings

4.2.1. Gear and Instrumentation

Based on the description given in the basic document and the oral presentations during the meeting, the Panel evaluated the WCVI Canadian survey equipment and protocols relative to international standards e.g. as described in Reid et al. (2007) and ICES (2009). This together with Canadian bottom trawl survey standardization manuals (Walsh et al. 1991, 2009) document international efforts to identify conventions that are applicable for most areas and conditions.

The trawl as sampling tool

In general, sampling of small pelagic fishes is challenging due to their high swimming speed and sensitivity to external stimuli, such as a moving and noisy trawling vessel (Misund 1999). The trawl net should include a large enough opening to allow a large volume of water to be sampled and should be constructed to allow high towing speed (>3.0 knots), thus enhancing catching efficiency. All surveys were conducted using a model 250/350/14 midwater rope trawl (Cantrawl Pacific Ltd., Richmond, B.C.). This is a relatively small pelagic trawl which appears easy and robust in routine operations. As such, it is an ideal survey trawl. Ropes and large meshes are used in the front part of the trawl opening, thus minimizing the resistance in water and allowing higher speed. Potentially, a disadvantage of this configuration is that the small size of the net may increase the probability of fish avoiding the gear (e.g., Suuronen et al. 1997, Misund 1999). The trawl is documented using drawings of trawl construction and rigging, including door specifications. However, some of the figures provided to the Panel were drawn by hand and were not always easy to interpret. The trawl construction should be included in the documentation of the survey standards.

Trawl instrumentation and operation

Conducting swept-area surveys requires knowledge of trawl geometry to enable area or volume densities to be calculated. Trawls are sensitive to environmental conditions, such as strong currents and winds, as well as operational mistakes. These may seriously impact the trawl geometry (height and width) and thus, the trawl opening, which is basic information for estimating densities. Also, operating the trawl at depths in accordance with survey protocols is demanding.

Thus, trawl instrumentation is normally used to ensure trawl operation according to certain standards (Walsh et al. 1991). The trawl net for the Canadian trawl survey is always equipped with one of three trawl sonars attached to the headline (Simrad FS-70, Westmar 770 SLED or Westmar 380 SLED). A third cable ensures continuous data stream and additional stretch to the headrope, which helps to stabilise the trawl opening. Trawl sonar is an ideal instrument for achieving a correct and constant trawl opening, and to determine that the trawl is probably functioning optimally when trawl opening is stable at target geometry. Also, this instrument draws the outline of the trawl, which is used to assess the amount of water filtered by the trawl. The footrope is expected to be directly under the headline, based on the construction of the trawl and its rigging as given in the trawl drawings. Assuming that the sonar is attached to the midpoint of the headline, it will draw the trawl opening at this part of the trawl, some meters behind the wingtips. The wingtips cover a wider area than that shown by the trawl sonar, and it could be argued that the trawl opening at the wingtips is more relevant for assessing densities because fish are probably herded by the wings. This would be an issue if catches are expressed as absolute densities, but is of minor importance for calculation of indices of relative abundance.

Standardisation procedures

Operational protocols help in making decisions on the validity of tows. Without such protocols, *ad hoc* decisions by personnel on watch may lead to biased and variable results, thus increasing the overall uncertainty of the survey. There are fixed routines for operating the trawl at a standard tow location, but there seems to be no protocol for handling sonar observations with respect to the deviation from standard specification, e.g., no definitive protocols are in place regarding how much deviation from standard trawl net geometry can be tolerated, before the tow is discarded or stopped and repeated. Presently, this is a decision taken by the fishing master on watch. There is a need for operational specifications that describe acceptable variation in geometry measures, before trawling is terminated and repeated, to achieve standard operation of the gear (e.g., Walsh et al. 2009). Such specifications and protocols will exclude or reduce impact on personnel change, i.e. when skipper or fishing master is replaced.

4.2.2. Calculation fish density from trawl catch data

Swept volume

A swept-area/volume assessment of fish density (D) requires that the properties of the gear and its operation are known. The effective opening of the trawl (the area effectively herding fish into the trawl) needs to be defined, measured, and monitored. The opening of the trawl has been defined as the area covered by the trawl sonar in the case of the WCVI surveys. This area was considered a rectangle dimensioned by the height (h) and width (w) as observed by the sonar. Distance towed (d) is needed to calculate swept volume. With 100% efficiency, D (kg/m^3) can be calculated from the size of the catch(c) as:

D=c/(h*w*d)

The quality of D is thus dependent of how well the properties h, w and d are observed or estimated. As noted above, the area covered by the sonar is likely to be a smaller than that over which fish are herded, but it is the ideal area to measure and monitor with the instruments available and thus, a good choice for precise measurements of trawl opening (h*w) and for estimation of relative densities. The distance (d) is based on GPS records of speed times tow duration in the WCVI surveys. However, this might be an imprecise estimate of distance towed due to uncertainty measuring tow speed. Such uncertainty may explain the large variation in tow speeds recorded during the surveys (although this variation may also be due to strong currents). A more precise measure of distance towed is the distance between the GPS position at start and stop, which avoids the need for an estimate of tow speed. Distance over the ground might be an imprecise measure of filtered volume if currents are strong. Nevertheless, it is probably better to use the distance over the ground than trying to assess filtered volume by, for example, recording the speed of water through the trawl. Such procedures need additional instrumentation, and measures of water speed through the trawl are often highly uncertain. The present procedure is to use a tow direction against wind, which is sensible given the need to maintain operational stability. This will cause some uncertainty related to the impact of current on the towed volume, i.e., it would be useful to record current direction and strength during each tow as an impact variable for later analysis.

Catchability

All the factors discussed above affect catchability (q); the relationship between trawl and true densities. While, in general, q might impact density by size (selectivity), in the case of small pelagic fishes, it will predominantly impact density measures, while size selection is less important. In general, changes to the survey vessel, as took place in the WCVI survey in 2005, could introduce unpredictable changes in q. The trawl is towed at the surface for a certain distance in the case of the WCVI survey, so the major factors are expected to be associated with vessel avoidance (Gerlotto et al. 2004, Ona et al. 2007) and trawl avoidance (Suuronen et al. 1997). Quantification of these factors is often difficult due to unpredictable variability and difficulties in obtaining appropriate measurements. Nevertheless, the issue should not be ignored because the trawling in the WCVI survey takes place close to the surface, with a short distance between the vessel and the trawl. Some straightforward studies could be implemented to monitor avoidance. For example, a vertical profile of the fish distribution under the vessel can be obtained if the vessel acoustics are monitored continuously. Similarly, the trawl sonar could be used to establish a depth distribution profile in the mouth of the trawl. There are many sources of uncertainty when comparing those two profiles, i.e., large impacts in the zone between the vessel and the trawl could be identified, but probably not quantified. Further, dedicated studies of avoidance, as have been conducted for the CPS acoustic-trawl survey, would be useful to provide an overview of the impact of these problems. Small pelagic species are high performing swimmers. In this context, escapement at the end of the tow caused by fish swimming in front of the trawl until retrieval may be more significant for shorter tows. The variability of all these factors affecting q emphasizes the importance of the Panel’s conclusion to keep tow duration as fixed as possible.

Realised catchability is also sensitive to imprecise measures of the actual sampled volume. The survey report describes instances when catching might have taken place during shooting/retrieval, i.e. outside the recorded tow volume. Thus, the effective distance towed might be longer than that recorded. This is particularly a problem when distance towed varies. The WVCI Survey Report indicates a wide range of tow durations (or distances). Catching during shooting/retrieval will affect short tows more than long tows. Consequently, tow duration should be kept as constant as possible and this issue should be borne in mind as a potential bias when analysing the data. Setting the tow start as soon as the standard opening is established and stopping the trawl when trawl geometry is distorted might be a way of minimizing these impacts. Catching during shooting and retrieval is particularly a problem if the distribution of the fish requires that trawling take place at various depths. In these cases, opening-closing devices could be a solution, although good techniques for fast swimmers, such as sardines might not be readily available.

4.2.3. Use of historical surveys

The time series of WCVI survey is made of a number of years with somewhat different practice. The question here is what years can be used to establish a timeseries for inclusion in the stock assessment. The most important issues were identified to be the spatial distribution of the tows, and the changes in sampling by time of day and depth.

Tow locations

The trawls during the surveys in 1999-2004, 2006, 2008 and 2009 followed similar spatial designs. The 2005 survey was aimed primarily at comparing day and night tows, rather than achieving good spatial coverage. The surveys in 2010 and 2011 are based on random designs, but with a slightly different area basis. Can the data from these designs be used to estimate an index of abundance by year? The sample data from the 2010 and 2011 are the best. Here the surveys can be used directly based on the mean of the samples over the design strata because the tow locations for these years were specifically selected on a random basis. Also, the strata variances calculated from the samples for the surveys during 2010 and 2011 are unbiased estimates of the precision of the estimates.

I find the 2005 survey having a poor spatial coverage, to be inappropriate to give unbiased estimate of abundance and variance. The surveys during the other years followed a quasi-stratified transect strategy, with 5 or 6 sets of tows allocated in lines across the area in an approximately east-west direction. In addition to these tows, extra tows were added in a haphazard way. Analysis of spatial correlations during the meeting indicated that the samples these years can be considered representative for estimation of the global mean and variance. Also, the observations in 2008 and 2009 should be considered though autocorrelations might bias the results.

Trawl depth

The trawl depths (depth of the headrope) were more variable prior to 2005 than after 2005. It is unsure to what extent this has affected the calculation as there are no clear information about the distribution pattern. Further analysis of this issue can be done during years with available acoustic data.

Time of day

Due to the variable practice over the time series there is further reason to exclude pre

2005 surveys from the time series. Before 2005 tows were predominantly carried out at day. Sardines are distributed deeper and in schools and this might affect catchability (q) (see above) as also will day/night differences in trawl/net avoidance. The time of day information supports using the time series from 2006 and onwards for stock assessment purposes. An objective definition of day and night according to height of sun is advisable.

4.2.4. Definition of the core area

The primary spatial-related issue to address is how to specify the boundaries of a core area. If a survey is to be defined and tow locations set, the area must be defined either in advance or in a way that is coupled to the analysis. The current (2011) proposal for the core area (Figure 1) appears reasonably sensible, but could be modified slightly to make the rationale for the boundary more explicit, as well as allow one or two minor additional aspects to be further evaluated.

The southern boundaries of the survey constituted by the Canada/USA border are administrative. The eastern boundary defined by the coast of Vancouver Island should be as close to the coast as is practical. As fisheries typically operate inshore, including some of the bays and inlets, it would be an advantage (both scientifically and politically) if possible to include these areas in the survey. This would give the survey direct relevance to those involved in the fishery. Use of a random placement grid (see below) could then be used to apportion tows to these areas appropriately. The northern and western boundaries should be in accordance to the distribution of sardine. As it is impossible to cover all areas in which sardine can occur, excluding a small amount of low-density area is reasonable. No survey catches of sardine above 1 t/km^3 are reported north of Vancouver Island (Figure 1), and only a few catches at higher densities are observed a few miles south of this line. It seems thus reasonable to limit the northern extent of the core area by this geographically-located point. The westward extent of the survey is more difficult to specify. Catches above 1 t/km^3 seems limited inside 45 km off the coast and shallower than 1,000 m (Figure 1). Defining the survey boundary by the greater of these two criteria would result in an overall data set that contains all previously observed densities. Defining the survey area in this may prevent waste of effort in areas without or with low densities of sardines.

4.2.5. Influence of environment (habitat)

Sardine habitat is defined as waters between 12 and 16ºC off southern and central California. (Checkley et al., 2000; Lynn, 2003; Zwolinski et al., 2011). High densities and spawning were observed off Oregon between 14 and 16 ºC. The appearance of sardine off western Vancouver Island is associated with waters warmer than 12 ºC (Ware, 1999). A recent study based on egg presence and remotely-sensed information over a 12-year period (Zwolinski et al., 2011) further refined the envelope of sardine potential habitat, and identified oceanographic conditions that likely influenced the migrations and the seasonality of the fisheries, to some degree. The duration of the availability of sardine habitat off western Vancouver Island is shorter than that off Washington and Oregon, suggesting a 4 to 6-month sardine season.

Detailed analysis of the appearance of sardine off the Columbia River mouth suggests that sardine arrive, in general, 2 to 4 weeks after the arrival of the habitat, and peak densities occur generally 1 to 2 months later than this. Information on sardine arrival off western Vancouver Island and its relationship to the potential habitat has not yet been explored, and could benefit from data from 'scouting trips.' Fishery landings indicate that the peak abundance of sardine off Vancouver Island is delayed in relation to the peak of potential habitat, but other logistics affecting fleet behavior could be driving peak landings times observed in the fishery.

4.2.6. Stratification of the survey area

Split of core area into strata depends on information about systematic differences in mean densities. Trawl catches give some evidence of such differentiation. The northern part of the region seems to have lower estimated densities. In addition, biological parameters change latitudinally. If the variation in biological information is to be included in the analysis, some stratification is required to spatially assign / raise biomass and biological parameters. Currently, there is no straightforward way to set stratum boundaries in the overall data set to predictably reduce variance, but rather, the function of stratification is to spread sampling more evenly across the core area and allow regional estimates to be obtained. The current approach of eight strata allows sampling with strata and a similar number of samples within each stratum. This appears to be a reasonable approach, but the impact of varying number of strata could be tested by simulation.

4.2.7. Trawl location design (random/ systematic)

Determination of the optimal placement of tows within the core area is an important issue for optimizing survey efficiency. The WCVI survey reports show that distribution of stations have varied over time from random to transect based and sometimes in an anarchic manner. The ICES held a workshop on survey design in 2005 in which a variety of designs were tested on simulated stock distributions with different spatial properties. Systematic and random punctual surveys were evaluated. The two simulated distributions (Section 2.1.1 of ICES (2005)) were used to evaluate the differences between a systematic survey design and a fully-random survey design.

The results show that a random design travelling salesman algorithm for defining the coverage is more efficient in terms of stations covered with constant effort (Figure 2). In terms of quality of the estimates, the result depends on the variance and spatial correlation of the catches (Figure 3). The interpretation of such analysis is not straight forward. The contrasting results for the two spatial distributions show that there is an interaction between spatial autocorrelation and sampling design. Further investigation of a wider range of situations with different properties would help to refine the parameters that influence when each survey strategy is the most efficient estimator of the abundance and variance.

The current approach of random tow allocation seems reasonable. The current methodology uses a 10 by 10 km grid for allocating ~3-5 km tows. It might be more appropriate to match the grid size to the towed distance.

4.2.8. Influence of migration (within area)

Temporal change in the population during a survey, which equates to changes during the survey, may affect the data and hence the abundance estimates. Sardine visits Canadian waters during its summer feeding migration, and movement of the stock during the survey is the most likely temporal issue. This applies to any survey, whether by trawl or acoustic methods. Following approach in Simmonds and MacLennan (2005) applied for acoustic surveys and rewritten in the context of trawl tows, rather than acoustic transects, gives some indications of potential errors of migration.

The movements of fish can be conceived as having two components, random motion and migration. In the former case, the fish swim at a particular speed in directions that change randomly with time. In the latter case, the fish swim consistently in the same direction. Simmonds et al. (2002) used a fine-scale model of North Sea herring schools, based on a spatial grid covering 120,000 km^2 with a node spacing of 40 m, to study the effect of fish movement on the results of simulated surveys. They found that reasonable amounts of random motion were unimportant to estimates of abundance or variance, but the effect of migration even at a modest speed could not be ignored. It is well known that some fish, such as Pacific sardine and related small pelagic species, migrate over long distances on an annual cycle. One factor in the survey design is the timing in relation to the migration cycle. The survey design should ensure that the surveyed area includes the entire stock. However, even if this condition is met, migration of the stock within the surveyed area can bias the abundance estimate. The extent of the bias depends on the direction of the migration in relation to the vessel motion.

In the case of WCVI survey, it is likely that the only plausible approach is a single direction survey, either from north to south or vice versa because the vessel port of origin is east of Vancouver Island. In this case, v_s can be estimated from the survey timing. If v_f could be estimated, the potential bias could be calculated.

Applying the approach by Simmonds et al. (2002) for the WCVI survey demonstrates that the impact of migration can be considerable and can be calculated (see Panel report). Migration of sardine in relation to the pelagic habitat is well documented (Zwolinski et al., 2011). Hence, variation in the environmental condition over time probably impact migration and thus survey results differently from year to year. Combining calculation of migration with estimation of dynamics of the pelagic habitat might enhance understanding of migration and its impact on survey estimates.

4.2.9. Raising fish density from tow to stratum density

Raising volume densities from trawl catches, as described in 4.2.2 to stratum densities requires consideration of depth coverage as well as how to accumulate point densities to stratum area.

The current approach assumes that the density estimates for 0-15 m are proportional to the area density. For computation of absolute biomass, the current approach for raising the observed trawl volume densities to the core area uses a standardized vertical extent of 30 m (e.g., Flostrand et al., 2011). This is a crude assumption that could be better documented. As the Canadian survey vessel is equipped with scientific echosounders an obvious approach would be to study vertical distribution and variation in this by means of acoustics.

The current method for raising area biomass density to the area of the strata follows common standards. The density estimates from the trawl are combined to calculate a global estimate of density, which is then raised to the abundance for the whole area. The biological samples are treated so that each fish sampled has equal weight. There are some annually repeatable trends in fish size that indicate differences in sardine density, both latitudinally and onshore-offshore (Table 1). The current calculation strategy removes the influence of the catch rate, because the data are not weighted by the size of tows. Alternatively the length and age distributions could be raised by the trawl-related density, but provisional calculation done during the meeting suggests the differences are small. Nevertheless, weighting by tow size is preferred. Care still needs to be taken when a small length-frequency sample is taken from a very large tow.

4.2.10. Estimating variance

Given the stratified random survey design, sample variance by stratum is the appropriate method to estimate the precision of the estimate of mean density. Also bootstrap methods and geostatistical approaches might be appropriate.

4.2.11. Abundance estimation

Total abundance for the core area can be estimated as the sum of the estimates for the individual strata taking area differences into consideration. Similarly, sampling variance for these estimates is the sum of the sampling variances by stratum. The survey length-frequency should be the sum of the stratum-specific length-frequencies, where the stratum-specific length-frequencies are the sampled length-frequencies weighted by the estimates of density by tow.

4.3. Recommendations

Tor 3: Recommendations for alternative methods or modifications to proposed methods

4.3.1. Gear and Instrumentation

The WCVI sardine survey has been under development and has changed in accordance with obtained experience. There is strong need for developing standards for the trawl gear, instrumentation and operations. This is becoming increasingly important if the survey time series is going to be integrated in the annual stock assessment. It is recognised that production of such a survey 'manual' can be a substantial piece of work. Such a document should not be fixed but should be updated as approaches and methods change. Such an official "living document" will enhance possibilities for understanding the quality of the time series in relation to the stock assessment. Good examples of such gear and instrumentation manuals are available for eastcoast Canada bottom trawl surveys (Walsh et al. 1991, 2009). The main content of such a manual is:

Documentation of trawl construction

Documentation of trawl instrumentation and its attachment to the trawl

Operational protocols of the for the trawl and its instrumentation

Operational standards and protocols for actions when measures do not meet standard requirements

Procedures for biological sampling

4.3.2. Calculation of fish point density from trawl catch

Density estimates depend on measurements of trawl geometry and towed distance. Quality measures of geometry is secured though proper use of the trawl instrumentation (4.3.1). Distance over ground is here used for the filtered volume calculations. This should be calculated as the distance between GPS positions at start and stop rather than speed multiplied by time, which can be very imprecise when using GPS speed. Using flow meter or acoustic Doppler current meter may improve the measure of filtered volume, but methods for this seems presently difficult due to difficulties in measuring the vertical water speed profile in the trawl.

A problem with catching prior and after start/stop of tow has been identified. Therefore setting the tow start/stop when the standard trawl operation characteristics have been obtained (geometry and speed)/and are lost should be considered. Also, using opening and closing devices to get precise filtered volume is an option that needs consideration.

Density estimates can be used in absolute terms or as indices. Knowledge about catchability (q) and its variability is essential in that respect. Evaluating and reducing variation in q enable approaching absolute estimates of densities for example through assessing fish avoidance to the trawl and variation in the vertical profile of the sardine by means of continuous acoustics measurements. Also, using the trawl sonar to establish a depth distribution profile in and around the mouth of the trawl might shed light on this source of variation. If these problems are experienced as serious, the possibility of dedicated studies of avoidance as for example has been done for the CPS acoustic-trawl survey, would be useful, and create a quantitative overview of the impact of these problems.

4.3.3. Definition of the core area

The current (2011) proposal for the core area appears reasonably sensible, but could be modified slightly to make the rationale for the boundary more explicit and to deal with one or two minor additional aspects. It would be helpful to include areas covered by the fisheries, thus giving the survey direct relevance to those involved in the fishery, if possible. Using historical data would define the westward extent of the survey at the greater of two criteria maximum based on the extent of non-trivial sardine density: 45km from the coast and the 1000m depth contour.

4.3.4. Influence of environment (habitat)

Evaluate Sardine habitat in WVCI area to see if waters between 12 and 16 ºC off southern and central California are also applicable (Zwolinski et al., 2011). Other temperature regimes should also be included in this analysis. If results are positive then consider using habitat estimated immediately prior to the survey to stratify effort annually in the core survey area.

4.3.5. Stratification of the survey area

The current approach of 8 strata gives samples per strata at a similar magnitude, and is thought to be reasonable. The optimal number of strata could be tested by simulation. Consider additional variable such as habitat (see above) to allocate effort in advance of each survey.

4.3.6. Trawl location design (random/ systematic)

It is recommended that trawl locations are determined prior to the survey, and an algorthim developed to utilize the time optimally. I recommend a stratified random. If the survey strategy is modified in the future to use acoustic daytime measures and night trawling the strategy might need to be reconsidered. Separation of time of day should be set objectively from the height of sun in relation to the horizon, e.g. using nautical or civil day/night definitions.

4.3.7. Influence of migration (within area)

It is recommended that the potential magnitude of the influence of migration be evaluated for the WCVI survey.

4.3.8. Raising fish density from tow to stratum density

The current approach assumes that the density estimates for 0-15m are proportional to the area density. It is recommended that further evaluation should be carried out, e.g. by using continuous acoustics to determine the vertical extent of the sardine distribution. Also using the observations from the trawl sonar might be helpful.

4.3.9. Estimating variance

Given the stratified random survey design, sample variance by stratum is the appropriate method to estimate the precision of the estimate of mean density. Bootstrapping of tow data (including biological data) could be used to estimate overall sampling precision. If the design were to be replaced by a different tow allocation regime (e.g., systematic), a geostatistical estimator would be appropriate.

4.3.10. Abundance estimation

The estimate of total abundance for the core area is the sum of the estimates of total biomass for the individual strata, computed by multiplying the estimated stratum density by the stratum area. The sampling variance for the estimate of abundance is the sum of the sampling variances by stratum. The survey length-frequency should be the sum of the stratum-specific length-frequencies, where the stratum-specific length-frequencies are the sampled length-frequencies weighted by the estimates of density by tow. It is recommended that the age-at-length data for the survey be computed from the raw age-length data available with adequate sample size (avoid samples with low number of fish measured).

4.4. Recommendations - stock assessment and/or management

Tor 4: Recommendations on application of the methods to the stock assessment.

4.5.

4.5.1. Use of historical surveys

Based on the available information it is recommended to use post 2005 surveys in the stock assessment.

4.5.1.1. Historical tow locations

The study of the variation in trawl location over time concluded with a recommendation of using data post 2005 as part of the time series to be used in the stock assessment. There are inconsistencies in design among these years, and there exists evidence of autocorrelation between the observations during 2008 and 2009. The spatial distribution of tows appears to differ across the area, particularly for 2009. The combination of differential spatial allocation and positive spatial autocorrelation suggests that the global mean and variance may be biased, although any biases may be small. Consequently, geostatistical analysis should be used to provide an unbiased estimate of mean and variance.

4.5.1.2. Trawl depth

The depth of trawl (quantified in terms of the depth of the headrope) was more variable in the historical surveys prior to 2005. Indications from the data presented are that there are differences in presence of sardine density with depth, where deeper tows tended to give lower densities and a higher proportion of zero sardine tows. It is unclear how much this might influence the mean density, but it is likely to bias the mean density relative to the densities estimated in the more recent surveys. One solution is to use only the shallower tows if these earlier surveys were to be used to construct a time-series.

4.5.1.3. Time of day

Tows were predominantly collected during daylight before 2005, although night data were also collected on some trips. In 2005 an additional vessel was used. It is discussed above that catch-rates during the day appear to be more variable than at night, and are probably also more representative. More recent surveys have been carried out at night and CVs are generally lower than those from the earlier predominantly daytime surveys.

Based on the observed the differences pre/post 2005, it is recommended that the surveys prior to 2005 are considered to be potentially inconsistent with those from 2006 onwards.

4.5.2. Inclusion in future stock assessments

Various time series derived from the WCVI survey could be utilized in the stock assessment for Pacific sardine such as *abundance indices* and *length-composition data* and *age-at-length data*.

Abundance indices

As discussed above there are strong demands on knowledge of catchability and its variability to enable estimation of absolute densities and indices of absolute abundance. Also, the value of such absolute abundance is limited as it is associated for the distribution in Canadian waters only. In addition, there are uncertainty in the east – west, north – south and surface – depth distribution patters with probably variable and unpredictable implication to the estimates. I therefore cannot see that now or in near future will see sufficient information to justify all assumptions needed for an absolute abundance estimation. Therefore the best use of biomass estimates from the survey would be as the basis for a relative index of abundance (i.e., catchability, q, be estimated in the assessment). The index from the core area could be considered as an index of abundance, as long as the factors that relate survey-selected biomass to the expected index for the core area remain constant over time. However, time-varying proportions of potential sardine habitat suggest that this assumption is unlikely to be valid. The problem of time-varying proportions of the population in the core area might be overcome in two ways: (a) the survey index can be assumed to be linearly related to survey-selected biomass, and the survey CVs increased to reflect among-year variability in the proportion of the survey-selected biomass in the core area; or (b) survey catchability can be allowed to vary over time, but be related to an independent measure of the proportion of the survey-selected biomass in the core area when the survey is conducted (e.g., be based on the output of a model of potential sardine habitat or sardine migration). The first of these options might effectively lead to the survey data being ignored within the assessment model, given the proportion migrating into Canadian waters may be highly variable. The second option might be preferable and it is recommended that work be undertaken to identify whether and how the model of potential sardine habitat can be used to provide an annual measure of relative survey catchability. Also, analysis of survey catchability in the assessment comparing WCVI survey with the other time series might give inter-survey relationships in q that might enhance the use of the data.

Length and age compositions

The surveys cover the more northerly component of the population, which is expected to include the largest and oldest sardine. Therefore the survey can be assumed to have an asymptotic (e.g., logistic) selectivity pattern, with an asymptote reflecting the maximum value at older ages. Size of sardine is observed to vary throughout the area. The Canada purse-seine fishery tends to occur closer inshore and at a slightly different time than the survey. Therefore the fishery and survey selectivity patterns should be assumed to differ unless it can be shown otherwise, e.g., by comparing age and length distributions.

Inclusion in the assessment

There are two approaches for including the available historical data from the WCVI surveys into the assessment: (a) start with the data for 2010 onwards and evaluate whether the model is able to mimic those data and, if so, consider including the data for 2006-09 as well, and (b) attempt to fit the entire time-series and if the model is unable to do this, restrict the data to those for 2010 onwards. As already stated, I consider that data prior to 2006 may not be consistent (see above) and ultimately, not useful presently for conducting formal stock assessments. The advantage of option (a) is that it attempts to fit the 'best' data first. In contrast, option (b) focuses on a longer time series and reduces the probability of the model mimicking the data spuriously. An additional advantage of option (b) is that the Panel does not expect that the differences in survey design for the 2006-09 surveys from that for the 2010 and 2011 surveys will lead to marked biases in the estimates of biomass. Irrespective of which option is chosen, the assessment report needs to summarize the changes in survey design and protocol over time and explicitly discuss the consistency of the time series. Given that only the 2011 survey was conducted using what is considers the 'best' design, it is strongly recommended that surveys be conducted during 2012 and 2013 to ensure that at least four years of comparable data are available if an assessment is conducted in 2013 (the next full assessment is currently scheduled for 2014).

It is further recommended that the following tasks should be undertaken prior to inclusion of the data from WCVI survey in the stock assessment: (a) the sensitivity of the estimates of biomass should be explored to omitting very short and long tows, and extreme vessel speeds; (b) geostatistical methods should be applied to estimate abundance (only for the 2008 and 2009 surveys); and (c) measures of relative survey q for the WCVI area should be computed using the model of potential habitat.

The migration issue needs further consideration. One possible option could be to compare variation in density distributions form the WCVI survey with those from the simultaneous Aerial survey taking place south of the Canadian border. Including sardine habitat modeling in this analysis might further enlighten the impact of migration.

5. Conclusions

The WVCI Survey Report and associated presentations together with the additional work carried out during the review give a good basis for the evaluation of trawl survey performance.

Several aspects of the survey gear description and procedures and routines for the operation were identified and a fulfillment of the recommendations of a survey manual as presented in this report will give more robust and reliable data in the future. The document should be used and adjusted ("living document") in accordance to state of knowledge. Otherwise, the survey is carried out in a way that should allow generation of a consistent index of abundance for Pacific sardine in Canadian waters.

The WVCI trawl survey time series can be considered to give estimates of distribution of abundance of Pacific Sardine for the survey area. Some reanalysis and exploration is required. Particularly, the distribution issue needs consideration to clarify the proportions of the sardine stock inside and outside Canadian waters at the time of the survey.

6. Recommendations

The following recommendations arising from the review are summarized below ranked in order of importance: H-high; M-medium; L-low; *-N/A):

1) Conduct surveys annually to ensure a time-series of comparable estimates is developed as quickly as possible. It is particularly important that surveys are conducted during 2012 and 2013 to ensure that at least four years of comparable data are available if an assessment is conducted in 2013. If it becomes necessary to conduct surveys every other year (rather than annually), it would be preferable to conduct the survey during a year in which a full stock assessment is conducted (H).
2) Conduct trawl surveys only at night (H).
3) Consider conducting an acoustic-trawl survey by towing at night and running acoustic transects during the day (H).
4) Establish a trawl manual that describes how the gear is standardized, including trawl drawings and rigging that can be easily interpreted by users. This should be a 'living' document, which is updated as needed. Develop and document standard routines for trawl operation that include better utilization of the trawl sonar output for standardizing and quality ensuring each tow (H).
5) Establish protocols for tow duration and speed in advance of the survey (H).
6) Use GPS the start and stop positions to calculate towed distance. If possible, ocean current velocities should be recorded for later impact studies of through water vs over ground tow speeds (H).
7) Generate the survey grid before the survey is undertaken and develop an algorthim to utilize the time optimally, including the use of longer intertow distances during the day (H).
8) For future surveys, create a larger number of potential tow locations so that the number of randomly drawn tows will represent a smaller percentage of possible tow locations (and more a random selection) (H).
9) Compute the conditional age-at-length data for the survey from the raw age-length data points (without weighting), but scale the length-frequency data to tow density, used to compute stratum length-frequencies and these summed to obtain the length-frequency for the entire survey (H).
10) Extend the USA habitat model northward to the Alaska border to provide a measure of the inter-annual component of relative survey catchability (H).
11) Assume that the WCVI survey has an asymptotic (e.g. logistic) selectivity pattern (H).
12) Assume that the Canadian fishery and WCVI survey selectivity patterns differ unless it can be shown otherwise (H).
13) Examine the results of model fits to assess whether the age-classes predicted to be covered by the aerial and WCVI surveys are biologically plausible (H).
14) Evaluate the possibility of using trawl opening and closing devices in case trawling at various depths become necessary (M).
15) Investigate the potential magnitude of migration on survey bias (M).
16) Investigate the assumption of a standardized vertical extent of 30m (M).
17) Develop a process for measuring volume sampled (M).

18) Investigate the impact of variation in the depth of sardine. Monitor the depth distribution of sardine (i.e. using acoustics) and consider changing the depth profile of the trawls if this changes (M).
19) Use object timing of day and night, e.g. in accordance with nautical or civil definitions of day and night (M).
20) Carry out avoidance studies to assess the potential impact of fish behaviour on the survey outcome. Over the short term, this would include comparing vertical profiles from vessel acoustics and the trawl sonar. Over the long term, more advanced studies, e.g. as done by the CPS acoustic-trawl survey team would be useful (L).
21) Should survey vessels change in the future, evaluate and monitor the impact of vessel changes in survey catchability, ideally using some form of calibration experiment (*).
22) Compare daytime acoustic biomass estimates with trawl-based estimates taken at the same time. If this proves to be impractical, then compare daytime acoustic estimates with trawl estimates taken the previous night (*).

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Table 1. Estimates of biomass and associated with sampling CVs using unstratified and stratified estimators.

(a) Estimates by stratum (estimates with CVs in parenthesis)

Stratum	Area	2006		2008		2009		2010		2011	
		N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
Ae	2582.0	7	527.5 (0.87)	7	0.0 (2.63)	17	464.4 (1.42)	9	267.4 (2.70)	12	412.4 (3.29)
Aw	1924.7	2	800.1 (1.41)	8	14.8 (2.49)	2	0.0	2	0.1 (1.41)	6	506.8 (1.28)
Be	2246.2	15	1817.7 (1.13)	6	304.6 (1.42)	22	584.6 (2.24)	10	489.5 (2.19)	9	455.0 (1.05)
Bw	1985.3	4	396.5 (1.94)	9	48.7 (3.00)	8	0.0	9	2.5 (1.21)	8	391.9 (2.46)
Ce	3378.5	10	407.2 (1.38)	15	612.6 (1.27)	28	737.4 (1.56)	18	186.8 (1.85)	17	504.5 (1.34)
Cw	2150.2	0		8	663.0 (1.07)	9	0.7 (2.78)	5	54.5 (1.43)	6	0.0
De	1336.2	4	249.0 (1.94)	3	21.1 (1.25)	8	12.1 (1.85)	1	0.0	6	31.2 (2.42)
Dw	1136.9	2	60.2 (0.01)	2	483.8 (1.20)	1	0.0	3	4.9 (1.73)	4	1.8 (2.00)

(b) Total abundance for the core area

Year	**Unstratified**	**Stratified**
2006	874.1 (0.24)	570.4 (0.24)
2008	280.4 (0.26)	291.7 (0.19)
2009	460.5 (0.22)	299.9 (0.21)
2010	157.0 (0.43)	152.3 (0.40)
2011	352.8 (0.27)	333.9 (0.26)

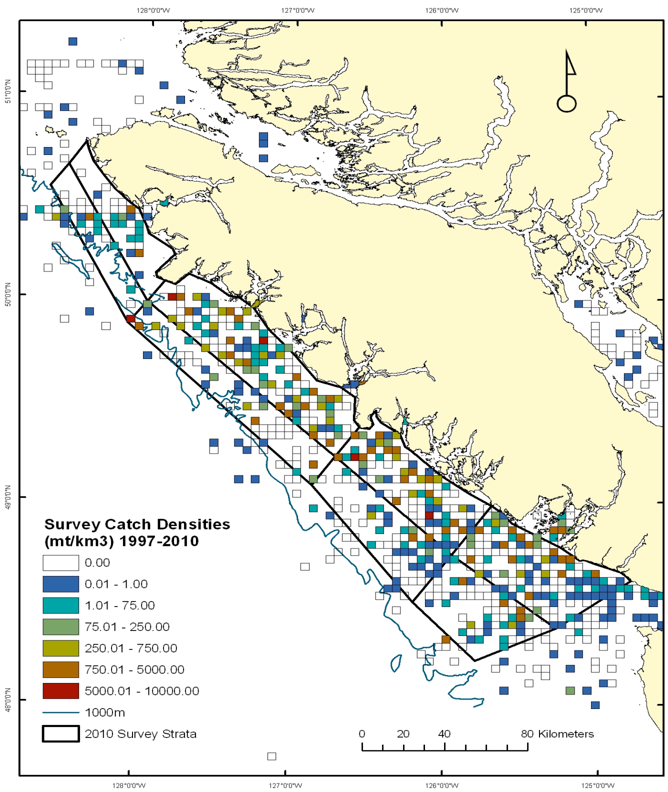

Figure 1. Mean sardine 1997-2010 trawl survey catch densities based on 4x4km sized grid cells and boundaries defining the core WCVI survey region applied in 2011.

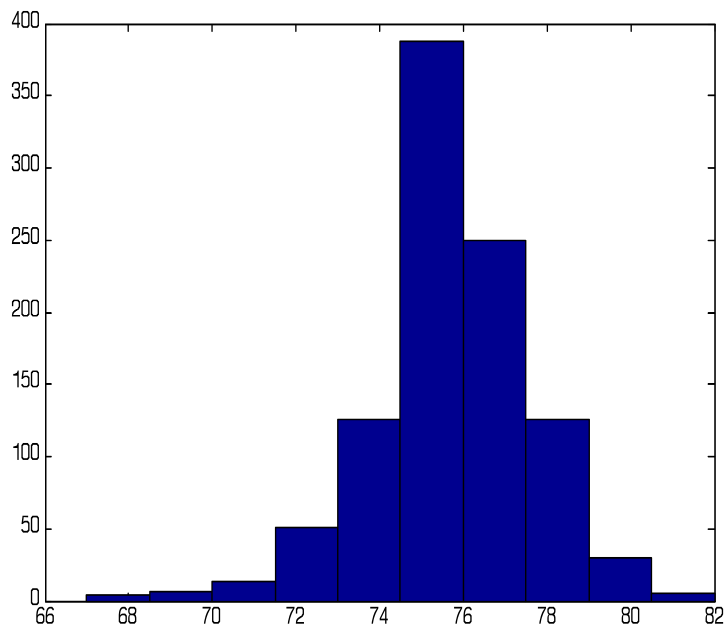

Figure 2. Number of randomly located tows in a fixed time with the minimum track obtained using the travelling salesman algorithm. (9 days with a survey speed of 10 knots and trawling time of 1.5 hours in a 14,400 N.mi^2 area) This compares with a systematic grid of 64 tows in the same time period.

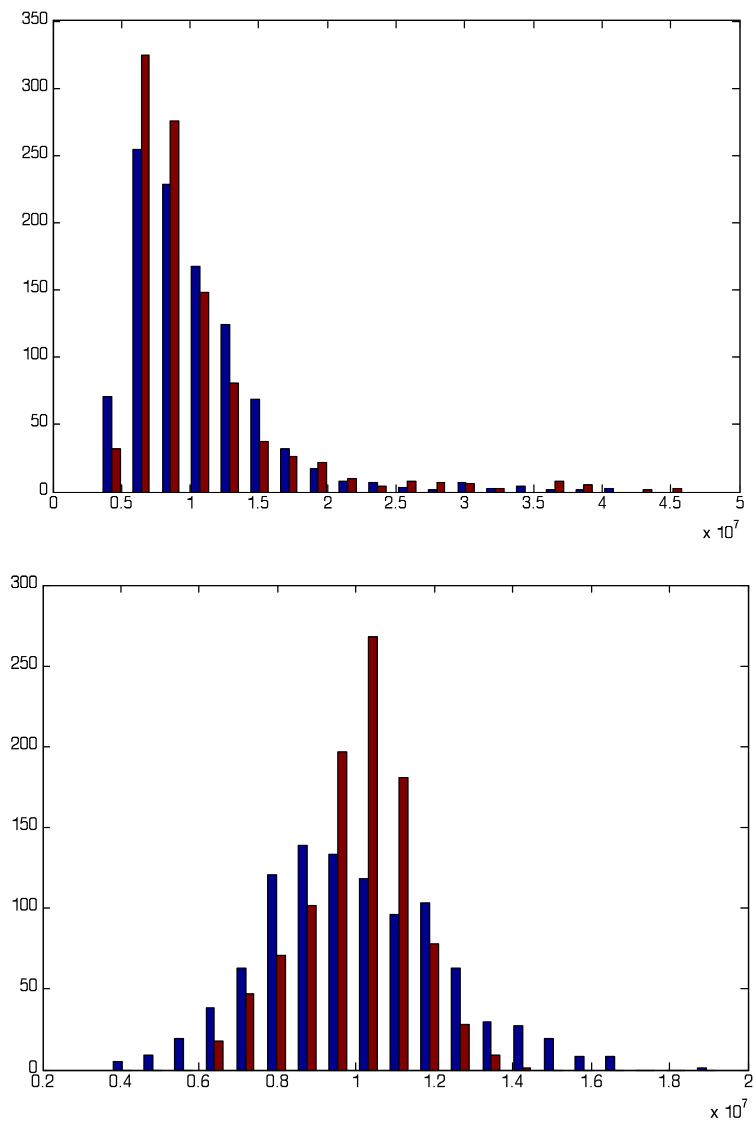

Figure 3. Frequency distribution of estimates of total abundance for a systematic survey design (red) and a random survey design (blue) for: a) a high variance, low correlation surface (upper panel); and b) a lower variance, but more correlated surface (lower panel).

Appendix 1: Bibliography of materials provided for review

Primary Documents

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Additional Background documents consulted

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Zwolinski, J. P., Emmett, R. L., and Demer, D. A. 2011 Predicting habitat to optimize sampling of Pacific sardine (Sardinops sagax). ICES J Mar Sci 68(5): 867-879.

APPENDIX 2:

Statement of Work for Dr. Olav Rune Godø

External Independent Peer Review by the Center for Independent Experts

Panel Methods Review of the Canadian Swept-Area Trawl Survey conducted along the West Coast of Vancouver Island for Inclusion into the Pacific Sardine Stock Assessment

May 29-31, 2012

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: The CIE reviewers will serve on a Methodology Review (MR) Panel and will be expected to participate in the review of the Canadian swept-area trawl survey conducted along the West Coast of Vancouver Island (WCVI Survey) for inclusion into the Pacific sardine stock assessment. The Pacific sardine stock is assessed regularly (currently, every year) by SWFSC scientists and the Pacific Fishery Management Council (PFMC) uses the resulting biomass estimate to establish an annual harvest guideline (quota). Independent peer review is required by the PFMC review process. The stock assessment data and model are formally reviewed by a Stock Assessment Review (STAR) Panel once every three years, with a coastal pelagic species subcommittee of the SSC reviewing updates in interim years. Fishery-independent data surveys, e.g., CalCOFI, acoustic, and aerial surveys are done annually to provide information to the model. Both the 2009 and 2011 Pacific Sardine STAR Panels recommended the addition of the WCVI survey as an additional fishery-independent data set, stating that the data set is potentially valuable since it provides abundance information for a large area within Canadian waters. Inclusion of the WCVI survey would also provide valuable insights into the northern most extension of the population, the largest size classes, and the timing and extent of migration during different years.

The MR Panel will review all pertinent survey and stock assessment documents and any other relevant information for Pacific sardine, work with the survey teams to make necessary revisions, and produce a MR Panel report for use by the PFMC and other interested persons for developing management recommendations for the fishery. The PFMC's Terms of Reference (ToRs) for the MR Panel review are attached in **Annex 2**. The tentative agenda of the Panel review meeting is attached in **Annex 3**. Finally, a Panel summary report template is attached as **Annex 4**.

Requirements for CIE Reviewer: Two CIE reviewers shall participate during a panel review meeting in La Jolla, California during 29-31 May, and shall conduct an impartial and independent peer review accordance with the SoW and ToRs herein. The CIE reviewers shall have the expertise as listed in the following descending order of importance:

- The CIE reviewers shall have expertise in the design and execution of fishery-independent surveys, such as swept-area trawls, for coastal pelagic fishes.
- The CIE reviewers shall have expertise in the application of fish stock assessment methods, particularly, length/age-structured modeling approaches, e.g., ‘forward-simulation’ models (such as Stock Synthesis, SS) and it is desirable to have familiarity in ‘backward-simulation’ models (such as Virtual Population Analysis, VPA).
- The CIE reviewers shall have expertise in the life history strategies and population dynamics of coastal pelagic fishes.
- It is desirable for the CIE reviewer to be familiar with the design and application of other fishery-independent sampling surveys such as aerial surveys and underwater acoustic technology to estimate fish abundance for stock assessments.

The CIE reviewer’s duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review process.

Location/Date of Peer Review: The CIE reviewer shall conduct an independent peer review during the MR Panel review meeting at NOAA Fisheries, Southwest Fisheries Science Center, 3333 North Torrey Pines Court, La Jolla, California from May 29-31, 2012.

Statement of Tasks: The CIE reviewer shall complete the following tasks in accordance with the SoW, ToRs and Schedule of Milestones and Deliverables specified herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering committee, the CIE shall provide the CIE reviewer information (name, affiliation, and contact details) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewer. The NMFS Project Contact is responsible for providing the CIE reviewer with the background documents, reports, foreign national security clearance, and information concerning other pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website:

http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send by electronic mail or make available at an FTP site to the CIE reviewer all necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE on where to send documents. The CIE reviewer shall read all documents in preparation for the peer review, for example:

- Recent Canadian WCVI survey documents including proceedings from the most recent Canadian Stock Assessment review (10 January 2012),
- Recent stock assessment documents since 2009,
- MR Panel- and SSC-related documents pertaining to reviews of past assessments,
- CIE-related summary reports pertaining to survey design and past assessments, and
- Miscellaneous documents, such as ToR, logistical considerations.

Pre-review documents will be provided up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process, including a SoW modification to the schedule of milestones and deliverables. Furthermore, the CIE reviewer is responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein.

Panel Review Meeting: The CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs. **Modifications to the SoW and ToR cannot be made during the peer review, and any SoW or ToR modification prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** The CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified in the contract SoW.

Respective roles of the CIE reviewer and MR Panel chair are described in Annex 2 (see p. 6-8). The CIE reviewer will serve a role that is equivalent to the other panelists, differing only in the fact that he/she is considered an 'external' member (i.e., outside the Pacific Fishery Management Council family and not involved in management or assessment of West Coast CPS). The CIE reviewer will serve at the behest of the MR Panel Chair, adhering to all aspects of the PFMC's ToR as described in Annex 2. The MR Panel chair is responsible for: 1) developing an agenda, 2) ensuring that MR Panel members (including the CIE reviewer), and STAT Teams follow the Terms of Reference, 3) participating in the review of the assessment (along with the CIE reviewer), 4) guiding the MR Panel (including the CIE reviewer) and STAT Team to mutually agreeable solutions.

The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: The CIE reviewer shall complete an independent peer review report in accordance with the SoW. The CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. The CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Other Tasks – Contribution to Summary Report: The CIE reviewer will assist the Chair of the panel review meeting with contributions to the Summary Report. The CIE reviewer is not required to reach a consensus, and should instead provide a brief summary of their views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

Specific Tasks for CIE Reviewer: The following chronological list of tasks shall be completed by the CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review;
2) Participate during the panel review meeting in La Jolla, California, from May 29-31, 2012, as called for in the SoW, and conduct an independent peer review in accordance with the ToRs (Annex 2);
3) No later than June 15, 2012, the CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and Dr. David Die., CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. The CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

April 17, 2012	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
May 15, 2012	NMFS Project Contact sends the CIE Reviewer the pre-review documents
May 29-31, 2012	The reviewer participates and conducts an independent peer review during the panel review meeting
June 15, 2012	CIE reviewer submits draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
June 29, 2012	CIE submits CIE independent peer review reports to the COTR
July 13, 2012	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be made through the Contracting Officer's Technical Representative (COTR) who submits the modification for approval to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the CIE within 10 working days after receipt of all required information of the decision on substitutions.

The COTR can approve changes to the milestone dates, list of pre-review documents, and Terms of Reference (ToR) of the SoW as long as the role and ability of the CIE reviewer to complete the SoW deliverable in accordance with the ToRs and deliverable schedule are not adversely impacted. The SoW and ToRs cannot be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (the CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards: (1) the CIE report shall have the format and content in accordance with Annex 1, (2) the CIE report shall address each ToR as specified in Annex 2, (3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon notification of acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the approved CIE reports to the NMFS Project Contact and regional Center Director.

Support Personnel:

William Michaels, Program Manager, COTR

NMFS Office of Science and Technology

1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910

William.Michaels@noaa.gov Phone: 301-427-8155

Manoj Shivlani, CIE Lead Coordinator

Northern Taiga Ventures, Inc.

10600 SW 131st Court, Miami, FL 33186

shivlanim@bellsouth.net Phone: 305-383-4229

Key Personnel:

Dale Sweetnam, **NMFS Project Contact**
Fisheries Resources Division, Southwest Fisheries Science Center,
8604 La Jolla Shores Dr., La Jolla, CA 92037
Dale.Sweetnam@noaa.gov Phone: 858-546-7170

Dr. Russ Vetter, Director, FRD,
Fisheries Resources Division, Southwest Fisheries Science Center,
8604 La Jolla Shores Dr., La Jolla, CA 92037
Russ.Vetter@noaa.gov Phone: 858-546-7125

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewer should describe in their own words the review activities completed during the panel review meeting, including providing a detailed summary of findings, conclusions, and recommendations.

   b. Reviewer should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewer should elaborate on any points raised in the Summary Report that they feel might require further clarification.

   d. Reviewer shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The CIE independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include as separate appendices as follows:

   Appendix 1: Bibliography of materials provided for review

   Appendix 2: A copy of the CIE Statement of Work

   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review of the WCVI Survey

Each CIE reviewer is one of the four equal members of the MR panel. The principal responsibilities of the MR Panel are to review survey design and stock assessment data inputs, analytical models, and to provide complete MR Panel reports.

Along with the entire MR Panel, the CIE Reviewer's duties include:

1. Review documents pertinent to the topic under consideration,
2. Evaluate the technical merits and deficiencies of the proposed method(s) during the panel meeting and work with the proponents to correct deficiencies,
3. Provide recommendations for alternative methods or modifications to proposed methods, or both, as appropriate during the panel meeting,
4. Provide recommendations on application of the methods to the stock assessment and/or management process,
5. Document meeting discussions,
6. Provide complete panel reports.

The MR Panel should strive for a risk neutral approach in its reports and deliberations and ensure that the research surveys, data collection, data analyses and other scientific techniques in support of the Pacific sardine stock assessment are the best available scientific information and facilitate the use of information by the Council.

The MR Panel, including the CIE Reviewers, is responsible for determining if a technical analysis is sufficiently complete. It is their responsibility to identify scientific techniques that cannot be reviewed or completed for any reason. The decision that a research survey may be incorporated into an assessment should be made by Panel consensus. If agreement cannot be reached, then the nature of the disagreement must be described in the Panels' and CIE Reviewer's reports.

Recommendations and requests to the STAT Team for additional or revised analyses must be clear, explicit, and in writing. A written summary of discussion on significant technical points and lists of all MR Panel recommendations and requests to the STAT Team are required in the MR Panel’s report. This should be completed (at least in draft form) prior to the end of the meeting. It is the chair and Panel’s responsibility to carry out any follow-up review of work that is required.

See attached file: Annex 2 PFMC Methodology TOR.docx

Annex 3

DRAFT AGENDA:

CANADIAN WCVI SURVEY METHODOLOGY REVIEW PANEL

Tuesday 29 May

08h30	Call to Order and Administrative Matters	
	Introductions	Punt
	Facilites, e-mail, network, ftp site, etc.	Sweetnam
	Work plan and Terms of Reference	Griffin
	Report Outline and Appointment of Rapporteurs	Punt
09h00	History of the WCVI Trawl Survey	Flostrand
10h00	Break	
10h30	WCVI Trawl Survey methods and results	Flostrand
12h30	Lunch	
13h30	Inclusion of WCVI survey into the U.S. Pacific Sardine assessment	Hill
14h30	Panel discussion and analysis requests	Panel
15h00	Break	
15h30	Public comments and general issues	
17h00	Adjourn	

Wednesday 30 May

08h00.	Assessment Team Responses	Flostrand
10h30	Break	
11h00.	Discussion and MR Panel requests	Panel
12h30	Lunch	
13h30	Report drafting	Panel
15h00	Break	
15h30	Assessment Team Responses	Flostrand
16h30	Discussion and MR Panel requests	
17h00	Adjourn	

Thursday 31 May

08h00 Survey Team Responses	Flostrand
09h00 Finalize MR Panel Report	Panel
10h30 Break	
11h00 Finalize MR Panel Report	Panel
13h00 Adjourn	

Annex 4: Methodology Review Panel Summary Report (Template)

- Names and affiliations of MR Panel members

- List of analyses requested by the MR Panel, the rationale for each request, and a brief summary the STAT responses to each request

- Comments on the technical merits and/or deficiencies in the assessment and recommendations for remedies

- Explanation of areas of disagreement regarding STAR Panel recommendations
    - Among STAR Panel members (including concerns raised by the CPSMT and CPSAS representatives)
    - Between the STAR Panel and STAT Team

- Unresolved problems and major uncertainties, e.g., any special issues that complicate scientific assessment, questions about the best model scenario, etc.

- Management, data or fishery issues raised by the public and CPSMT and CPSAS representatives during the STAR Panel

- Prioritized recommendations for future research and data collection

APPENDIX 3:

Participants and Agenda

Methodology Review Panel Members:

André Punt (Chair), Scientific and Statistical Committee (SSC), University of Washington

Ray Conser, SSC, NMFS, Southwest Fisheries Science Center

Olav Rune Godø, Center for Independent Experts (CIE)

John Simmonds, Center for Independent Experts (CIE)

Pacific Fishery Management Council (Council) Representatives:

Kirk Lynn, Coastal Pelagic Species Management Team (CPSMT)

Mike Okoniewski, Coastal Pelagic Species Advisory Subpanel (CPSAS)

Kerry Griffin, Council Staff

Technical Team:

Linnea Flostrand, DFO, Canada

Jake Schweigert, DFO, Canada

Paul Crone, NMFS, SWFSC

Others in Attendance

David Demer, NMFS, SWFSC

Emmanis Dorval, NMFS, SWFSC

Kevin Hill, NMFS, SWFSC

Kristen Koch, NMFS, SWFSC

Nancy Lo, NMFS, SWFSC

Josh Lindsay, NMFS, SWFSC

Sarah Shoffler, NMFS, SWFSC

Dale Sweetnam, NMFS, SWFSC

Russ Vetter, NMFS, SWFSC

Cisco Werner, NMFS, SWFSC

Juan Zwolinski, NMFS, SWFSC

Agenda

<u>TUESDAY, MAY 29, 2012 – 8:30 A.M.</u>

A. Call to Order, Administrative Matters, and Approval of Agenda	Andre Punt
Facilities and Logistics	Dale Sweetnam
Work Plan and Terms of Reference	Kerry Griffin
Report Outline and Appointment of Rapporteurs	Andre Punt
B. History of the WCVI Trawl Survey	Flostrand/Schweigert
(9 a.m., 1 hour)	
BREAK	
C. WCVI Trawl Survey Methods and Results	Flostrand/Schweigert
(10:30 a.m., 2 hours)	
LUNCH	
D. Inclusion of the WCVI Trawl Survey in the U.S. Sardine Assessment	Paul Crone
(1:30 p.m., 1 hour)	
E. Panel Discussion and Panel Requests	Panel
(2:30 p.m., 0.5 hours)	
BREAK	
F. Public Comment, General Issues	
(3:30 p.m., 1.5 hours)	
ADJOURN DAY 1	

<u>WEDNESDAY, MAY 30 – 8:00 A.M.</u>

G. Responses to Panel Requests	Flostrand/Schweigert
(8 a.m., 2.5 hours)	
BREAK	
H. Panel Discussion and Requests	Panel
(11 a.m., 1.5 hours)	
LUNCH	
I. Report Drafting	Panel
(1:30 p.m., 1.5 hours)	
BREAK	
J. Responses to Panel Requests	Flostrand/Schweigert

(3:30 p.m., 1 hour)

K. Discussion and Panel Requests Panel

(4:30 p.m., 0.5 hours)

ADJOURN DAY 2

THURSDAY, MAY 31, 2012 – 8:00 A.M.

L. Responses to Panel Requests Flostrand/Schweigert

(8 a.m., 1 hour)

M. Finalize Panel Report Panel

(9 a.m., 1.5 hours)

BREAK

M. Finalize Panel Report (continued) Panel

(11 a.m., 2 hours)

ADJOURN